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OBSERVATIONS ON THE PREY AND NEST CLUSTERS OF *PODALONIA VALIDA* (CRESSON) (HYMENOPTERA: SPHECIDAE)

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Abstract.—In northern Colorado, *Podalonia valida* preyed upon mature larvae of the saltmarsh caterpillar, *Estigmene acrea* (Drury), the same prey it uses in Arizona. Prey were deposited in shallow, single-celled nests that occurred within clusters probably provisioned by single females. Because females forage for abundant nearby prey, stock each nest cell with a single caterpillar, and dig simple nests in a localized area, they have the potential to provision multiple nests over short time periods. Several observations are consistent with this hypothesis. First, within clusters of nest cells, there was a high degree of synchrony in developmental stages of the wasps, suggesting that eggs were laid in quick succession. Second, dissections showed that female *P. valida* carry more mature eggs in their ovaries than is typical for non-parasitoid aculeate wasps.

Key Words: Digger wasp, Sphecidae, nesting behavior, egg size, *Estigmene acrea*, saltmarsh caterpillar, Arctiidae

Wasps of the genus *Podalonia* dig short burrows terminating in a cell provisioned with a single prey (Bohart and Menke 1976). *Podalonia luctuosa* (Smith) (O'Brien and Kurczewski 1982), *Podalonia robusta* (Cresson) (Kurczewski et al. 1992), and *Podalonia argentifrons* (Cresson) (O'Brien 1983) restrict themselves to cutworms (Noctuidae), but may take a variety of species at any one site. Similarly, *Podalonia occidentalis* Murray apparently prey solely on tent caterpillars (Lasiocampidae: *Malacosoma*) (Evans 1987) and *Podalonia valida* (Cresson) limit themselves to arctiid moth caterpillars. Steiner (1974, 1975) found *P. valida* specializing on saltmarsh caterpillars (*Estigmene acrea* (Drury)) in southern Arizona, whereas Rust et al. (1985) found two female *P. valida* taking *Apantesis proxima* (Guérin-Méneville) on San Clemente Island, California. Here, we present results of our observations of the nesting behavior and prey of *P. valida* in northern Colorado and compare our findings to those of Steiner, who concentrated on the hunting and territorial behavior of females.

METHODS

We studied *P. valida* females at the Pawnee National Grasslands in northern Weld Co., Colorado, from 12 July to 13 August 1984. The site was situated along a sandy, little-used road that passed through prairie consisting of grasses mixed with several common forbs, notably white sweetclover (*Melilotus alba* Desr.) and sunflower (*Helianthus* spp.).

RESULTS AND DISCUSSION

Our 64 prey records indicate that *P. valida* preyed exclusively on mature larvae of the saltmarsh caterpillar *Estigmene acrea* (Drury) (Arctiidae), the same species used by this wasp in Arizona (Steiner 1974). The prey of *P. valida*, which were probably taken on their host plants (white sweetclover), were carried in the mandibles as females walked forward straddling the prey. One female carried a caterpillar at least 10 m before reaching her nest. Prey-carrying females occasionally stopped and cached their prey ~5 cm above the soil surface on small plants, where they were left for several minutes while females searched for their nests.

Unlike other species of *Podalonia*, *P. valida* dig nests before hunting (Steiner 1974, 1975). Each nest at our site consisted of a short, oblique burrow about 1 cm in diameter, terminating in a single 1 × 3 cm cell situated 3–5 cm beneath the soil surface (N = 7). Typically, when digging the nest, a female backed out 5–10 cm from the burrow entrance and scraped soil backwards with her forelegs, while elevating her abdomen, flicking her wings rapidly, and buzzing loudly. Upon returning to her nest with prey, a female dropped it at the entrance, cleared the burrow, and pulled the prey inside while moving backwards. After several minutes inside the nest, during which time she laid an egg on the prey, the female emerged and permanently closed the burrow by scraping in soil from the edge of the burrow and placing lumps of soil or pebbles in the hole. She then tamped the loose soil with her head (mandibles wide open) or with a lump of soil which was held in the mandibles and which broke up due to the impact. The entire sequence between entering the hole with prey and completing closure typically took about 4 minutes.

These observations are in accord with those of Steiner (1974, 1975), who found that individual females provisioned series of single-celled nests within small patches of bare soil sometimes no more than 60 cm across. Although we did not observe individually marked females over prolonged periods, we also found that cells tended to be clustered. In 2 of our 7 excavations of recently completed nests, we unearthed just a single cell, but in the others, we found clusters of 8, 15, 16, 18, and 27 cells within areas no more than 0.25 m^2. Some cells were separated by as little as 5 cm, but were definitely parts of different nests. Clusters of nest cells were well-separated from one another and each was apparently used exclusively by a single female, who vigorously attacking conspecific females intruding upon their nest cluster in interactions that included bouts of grappling between the combatants. Similar interactions between *P. valida* females have been described in detail by Steiner (1975).

The contents of unparasitized and nonmoldy *P. valida* cells within clusters suggest that, if a single female was responsible for all of the cells, some were provisioned during short time intervals. For example, in the cluster of 15 cells, 5 had prey with wasp eggs, 3 had prey with small wasp larvae, and 1 had a large wasp larva. In the cluster of 7 cells, all had prey with unhatched eggs. Similarly, the cluster of 18 cells included 7 prey with wasp eggs and 7 with small wasp larvae, and the cluster of 16 cells contained 7 with eggs or small larvae.

The potential ability of *P. valida* females to provision multiple nests in rapid succession may be possible because they 1) forage for abundant prey nearby, 2) stock each cell with a single prey, and 3) dig simple, shallow nests without searching widely for successive nesting sites. This strategy may allow them to exploit a single developmental stage of a single prey species that is available for just a brief period during the summer. However, the rapid stocking of multiple nests would also require that a female produce the requisite numbers of eggs. Typically, female sphecids carry no more than two mature eggs at a time, although they have three ovarioles in each ovary (Iwata 1964, O'Neill 1985). Nevertheless, the three *P. valida* females that we captured within minutes of their laying eggs had 3, 5, and 6 mature (or nearly mature) oocytes still in their ovaries. Thus, the latter female had been carrying seven well-developed oocytes just prior to capture and had one ovariole with two mature oocytes. In Iwata's extensive survey of the ovaries of solitary aculeate wasps, only parasitoid sphecids of the genera *Larra* (with up to 21 mature oocytes) and *Chlorion* (with up to 10) carried more mature eggs than the maximum for *P. valida*. Such high levels of short-term fecundity (for a digger wasp), however, may be achieved at the cost of producing smaller eggs. The mature oocytes of *P. valida* ranged in length from 2.6–3.1 mm in length and one egg found on prey was 2.9 mm long. In contrast, in the similarly-sized but less fecund wasp *Philanthus bicinctus* (Mickel), mature oocytes and newly laid eggs ranged as high as 5.4 mm in length, and had perhaps 3–4 times the volume of *P. valida* eggs (O'Neill 1985). *Bembecinus quinquespinosus* (Say) and *Philanthus pulcher* Dalla Torre carry 1–2 mature oocytes within the same size range as *P. valida*, although they are both much smaller wasps.

Of the 86 cells we excavated, four had fly puparia 0.5–1.0 cm below the cell, which in each case-contained the remains of a single saltmarsh caterpillar. One puparium gave rise to a tachinid of the genus *Exorista*, at least one species of which is a known parasitoid of *E. acrea* (Arnaud 1978). The wasps had probably captured previously parasitized caterpillars and suffered incidental cleptoparasitism. Another 23% of the cells contained molded or rotting caterpillars.

Our observations complement those of Steiner (1974, 1975), indicating that two widely separated populations of *P. valida* have identical prey preferences and similar nesting behaviors that are unique for this genus. *Podalonia valida* seems to have adopted a strategy intermediate between those of the relatively high fecundity parasitoid sphecids (*Larra* and *Chlorion*) and the more typical low fecundity nest provisioning species that spend considerable time and energy on each offspring. This strategy is facilitated by the greater number of mature eggs they carry and, perhaps, by shorter periods of searching for potential nest sites once nesting has begun.

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